INFORMATION SHEET FOR THE FY2022 NOAA/OAR/WPO *FIRE WEATHER AND ATMOSPHERIC COMPOSITION* COMPETITION

Fire Weather

The Organic Act of 1890 provides NOAA broad authority to provide weather and climate information for the nation. Other Federal actions, such as the 1988 Stafford Disaster Relief and Emergency Assistance Act and the 2017 Weather act, directs NOAA to work to support state and local emergency assistance efforts through improved observations, forecasts, and impact-based decision support services (IDSS), including those associated with wildland fires. These activities span a range of timescales in the fire lifecycle, from subseasonal-to-seasonal (S2S) prediction of conditions that are correlated with a high likelihood of dangerous wildfire (e.g., drought conditions), to early ignition detection, short-term and medium-term forecasting associated with the near-fire environment and the downstream air quality, and post-fire hazards.

The increase in the frequency of drought and hot-dry-windy conditions over the last several decades, combined with the continued expansion into the wildfire-urban interface region, has led to a marked increase in the number of acres burned by hazardous wildfire. The number of wildfires and the acres burned are projected to further increase as the climate warms, with profound changes to certain ecosystems. Wildfires threaten forest and grasslands, housing and communities, aquatic and soil ecosystems, and air quality both near to and far from the fires, and ultimately costs the Nation billions of dollars a year when accounting for the local costs of damage to buildings and communities and the downstream impacts on human health associated with smoke and the resulting poor air quality.

There are a large number of gaps that need to be addressed to provide better predictions and tools to help forest and emergency managers, operational forecasters, and local, state, and national agencies better prepare and address hazardous wildfires. Some of the gaps are due to lack of **observations** or the current inability to utilize these observations as well as possible in high resolution modeling systems. Acquiring and maturing the use of technologies to incorporate profiles of temperature, humidity, wind, and fire emissions into NOAA modeling systems will provide new insights into interactions among fire, weather, chemistry, and air quality.

Other gaps are associated with uncertainties or lack of capability of **predictive modeling systems**. Improvements **in Unified Forecast System (UFS) synoptic and S2S models**, which are used to predict drought and other conditions correlated with hazardous fires and thereby allow communities to prepare for potentially dangerous conditions, are drastically needed. A **coupled fire-atmosphere high resolution modeling system** is needed to predict how a currently burning

fire might spread in the hours-to-days ahead time frame. **Ensemble prediction systems** are needed to provide probabilistic guidance for various stakeholders on how fires might spread and impact downstream air quality.

NOAA is moving toward a unified modeling approach to support prediction of extreme weather and its associated drivers at extended time ranges. Fire weather development projects must focus on developing the UFS and are encouraged to coordinate with developments under the Unified Forecast System Research to Operations (UFS R2O) Project. UFS developments are furthermore encouraged to articulate how they would collaborate with the Earth Prediction Innovation Center (EPIC), leveraging and incorporating scientific advances to adopt EPIC's continuous improvement continuous deployment framework, providing code documentation, incorporating code testing, or utilizing cloud computing. See the EPIC website at https://wpo.noaa.gov/Programs/EPIC for further information on the Center and its activities.

Lastly, there are gaps in the **tools** needed to present these advanced observations and forecast model predictions in easy-to-understand, interactive ways to the user community. These tools should enable better communication of the risks and evolving conditions, to ultimately help to save lives and property, improve downstream health impacts from the emitted smoke, and save potentially millions of dollars.

Fire weather projects that are most appropriate for this competition may fall along a broad range of readiness levels, from development (RL 2-4) through the "demonstration" level of technical maturity (RL 5-8). Transitioning a mature demonstrated capability from level 8 to 9 is beyond the scope of this funding opportunity but could occur after the project's end.

PIs selected for funding projects with expected (RLs 5-8) will collaboratively develop R2O Transition Plans in coordination with designated operational line office staff within six months of the project start date. This plan will outline how the project outcomes are envisioned to be transitioned to operations. NOAA guidance will be provided for the development of R2O Transition Plans.

Atmospheric Composition

NOAA collaborates with the external science community on improving NOAA's atmospheric composition and air quality forecasting capabilities through applied research and provides financial support for research-to-operations (R2O) transition projects through the United States Weather Research Program (USWRP) to accelerate their transition to operations and to enhance the public benefits derived from these projects. To get a sense for the types of current and past air quality research and forecasting projects funded by WPO, please go to https://wpo.noaa.gov/Funding/Funded-Projects and sort by the "Air Quality Forecasting" theme.

The National Air Quality Forecasting Capability (NAQFC) provides nationwide operational predictions of ozone, suspended fine particulate matter (PM), and wildfire smoke, as well as airborne dust from dust storms over the contiguous lower 48 states. NOAA predictions are produced for two days at 12 km resolution and 1 hour time intervals and are distributed in numerical and graphical format at https://airquality.weather.gov/. Ozone and PM prediction are achieved by off-line coupling the NOAA National Center for Environmental Prediction's (NCEP) operational meteorology forecasts with inventory-based emissions estimates from the EPA, natural source emissions from wildfire smoke and dust, and chemical processes within the EPA Community Multiscale Air Quality (CMAQ) model. The Global Forecast System (GFS) provides the meteorological drivers for NAQFC currently. NCEP's Environmental Modeling Center will make Finite Volume Cubed Sphere (FV3) code available on Github by late 2021.

The Global Ensemble Forecast System-Aerosols (GEFS-Aerosols) was implemented into operations in September 2020. GEFS-Aerosols is an atmospheric composition model that integrates weather and air quality using the FV3 core. GEFS-Aerosols produces forecasts of the global distribution of smoke, soot, organic carbon, sulfate, and large and small particles of dust and sea salt. The atmospheric chemistry component of GEFS-Aerosols is based on the Weather Research and Forecasting (WRF) model coupled with Chemistry (WRF-Chem). The aerosol modules are based on the NASA Goddard Chemistry Aerosol Radiation and Transport model (GOCART). Global anthropogenic emission inventories are derived from the Department of Energy's Community Emissions Data System. GEFS-Aerosols also includes a new dust emissions algorithm, FENGSHA, and biomass burning plume rise module from WRF-Chem.

Emissions used for ozone and PM2.5 predictions are updated regularly with improvements including projected changes in emissions from point and mobile sources (reducing NOx emissions especially in the eastern US), and inclusion of smoke and dust sources in CMAQ with updates to CMAQ chemistry. In February 2017, the CMAQ model that provides operational ozone predictions was upgraded to use a newer CB05 chemical mechanism and includes the AERO6 module and real-time smoke and dust emissions to provide operational PM2.5 predictions from the same system.

Projects focusing on atmospheric composition research and forecasting that are relatively mature and not in the early stages of development or proof-of-concept are appropriate for this funding opportunity. This includes those projects that propose practical outcomes that could be transitioned operationally to NOAA in the next 3 to 5 years. In the parlance of NOAA and other federal agencies, this requirement translates to the higher "readiness levels". Readiness levels, as adopted by NOAA per NAO 216-105B, have been described in the associated NOFO for this competition and announcement in Section I.A "Program Objectives". Please refer to that section for additional information.

Atmospheric composition projects that are most appropriate for this competition generally fall in or near the "demonstration" level of technical maturity, i.e., readiness levels of about 5 through 8 during the duration of the project. Ideally, the transition of a funded project from readiness level 5 or 6 at start-up to 8 at completion is OAR's driving goal in funding these projects. On the other hand, projects in early stages of development or proof-of-concept during the project period (i.e. those with start-up readiness levels of 4 or below) are not the focus of this funding opportunity. Transitioning a mature demonstrated capability from level 8 to 9 is beyond the scope of this funding opportunity but could occur after the project's end if they are successful and approved for operational implementation by NOAA's National Weather Service (NWS). Completed projects satisfying NWS metrics for success and operational constraints (e.g. added value, ease of use, computational efficiency, etc.) may be selected later for operational implementation by appropriate NWS operational offices.

PIs selected for funding for atmospheric composition projects will collaboratively develop R2O Transition Plans in coordination with designated NWS staff within six months of the project start date. This plan will outline how the project outcomes are envisioned to be transitioned to NWS operations. NOAA guidance will be provided for the development of R2O Transition Plans.

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